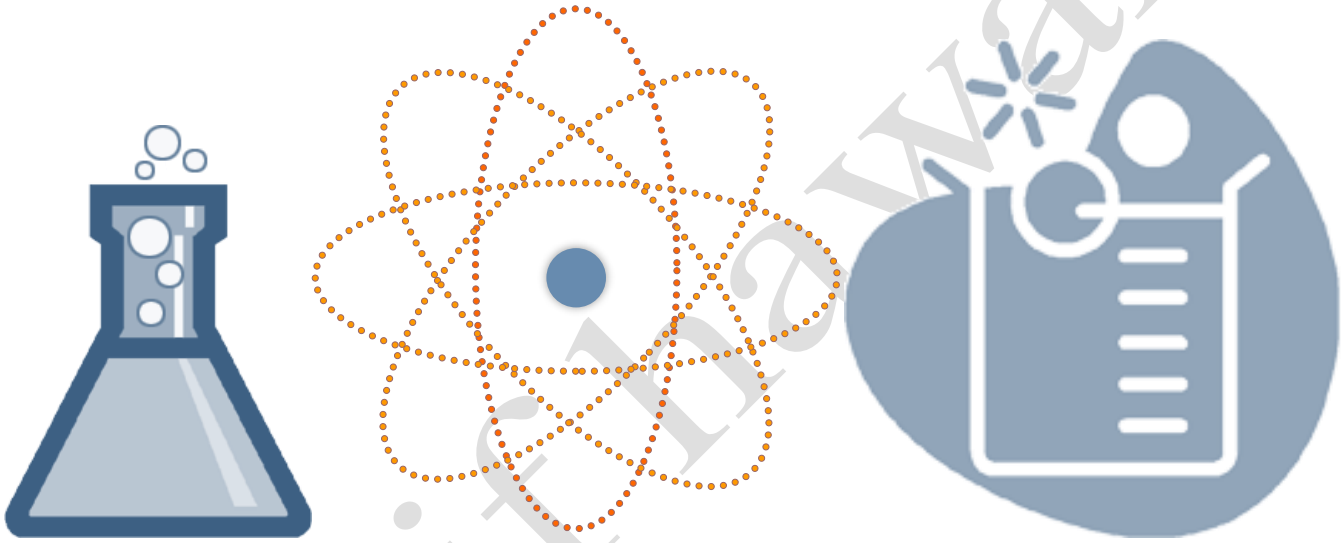
Chemistry

First Secondary



Mr. Sherif Hawary

sherifhawary

Unit One

Chapter 1

Chemistry and measurement

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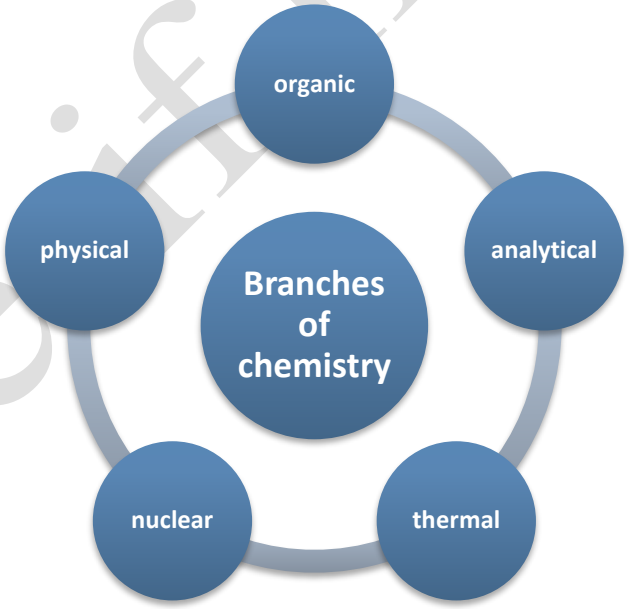
science

An organized structure of knowledge that includes facts, principles, laws and scientific theories.

Chemistry

Science that studies the composition, properties of matter, changes that occur to it and reactions between substances.



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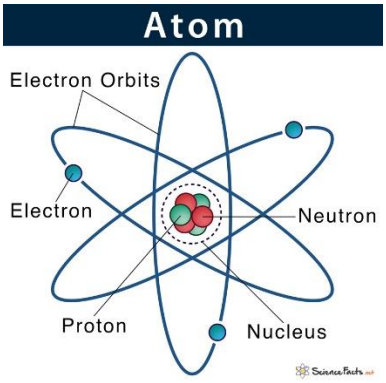
Fields of Chemistry

In ancient times

- ✓ Metal and mining
- ✓ production of colors and glasses.
- ✓ Tanning and dying clothes
- ✓ Medicines.
- ✓ Mummifying

Nowadays

- ✓ properties of substances.
- ✓ Structure of atoms and molecules.
- ✓ Solving some problems as pollution



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Relation between chemistry and other branches of science

Biology

Biology: Study the living organisms.

Chemistry: Study reactions inside the body as digestion

Chemistry + biology = Biochemistry

Biochemistry:
Science study the chemical structure of proteins, fats and carbohydrate

Physics

Physics: study natural phenomena as motion , force, light.

Chemistry + physics = Physical chemistry
Study
-Properties of substances.
-Structure of these substances

Medicine & Pharmacy

Chemistry studies:
Nature and function of hormones and enzymes in the body.

Medicine:
they are chemical substances that have healing properties.

Agriculture:

Chemistry helps in:

1-Choosing the suitable soil.
2-Suitable fertilizer

Future

Discover substances with extraordinary properties through nano chemistry

Measurement in chemistry

Measurement:

Comparison of unknown quantity with another known one.

Results of measurement:

1-Numerical value: to describe the physical quantity
2-Measuring unit

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Measuring unit:

It is a certain portion of a certain physical quantity

Importance of measurement:

1-Gaining information about substances.

2-Monitoring and rotection.

3-Evaluate a situation and suggest medicine as (glucose in blood)

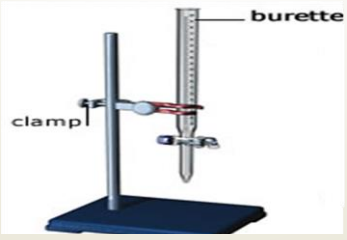
Measurement Tools

Sensitive Balance

- **Use:** measure the mass of substances
- **Types:** Digital balances
- **Most common:** Top loading balances

Burette

- **Description:** Long glass tube with two opening the graduation zero is close to upper opening
- **Use:** Titration
- **Note:** It should be fixed on a holder with a metallic Base



Beakers

- **Use:** Measure approximate volume of solutions
  Transporting solutions
- **Description:** transparent beakers made of pyrex glass

Pipette

- **Description:** Long glass tube opened from the two sides
- **Use:** Measure and transport certain volume of solution
- **Note:** vacuum should be used to avoid harms

Graduated cylinder

- **Use:** Measure the volume of liquids with high accuracy
  Measure the volume of solid

Flasks

- **Description:** has many shapes

Type	Conical flask	Round-bottom flask	Volumetric flask
Use	Titration	Preparation and distillation	Prepare solution with accurate concentration

Tools for measuring PH

PH:

- It is the measurement that determine if the substance is acid or base or neutral.
- It is the measurement of concentration of hydrogen ions in solution.

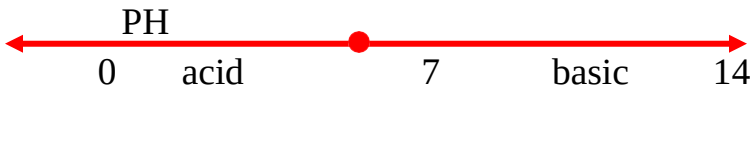
Tools to detect PH

- litmus paper (by changing their color)
- Digital apparatus (more accurate and it measures PH directly)

-PH < 7 acid

-PH = 7 neutral

-PH > 7 base



PH meter is more accurate in measuring PH of a solution. (G.R)

Because PH meter can determine if the solution is acid or base and also determine the concentration of hydrogen ions in the solution while PH tape is used to know if the substance is acid or base only

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Chapter 1

❖ *Write the scientific term:*

a. The science which is interested in studying the chemical structure of the parts of the cell.

(……..)

b. The science that is interested in studying the properties and structure of matter

(……..)

c. Chemical compounds that have healing properties.

(……..)

d. A flask used in titration.

(……..)

e. A glass tube with two opening used to measure and transport a certain volume of liquids.

(……..)

f. A flask used to prepare solution with very accurate known concentration

(……..)

g. A digital apparatus used to measure PH value.

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(……..)

❖ Choose the correct answer:

1. The PH value of a basic solution is……

   a) > 7 b) < 7 c)=7 d)=14

2. Most of tools in the chemistry laboratory are graduated from the lower to the upper except……

   a) flasks b) graduated cylinders

   c)burette d) graduated beakers

3. Physical chemistry is the science that specialized in studying…….

   a)structure and properties of matter b)the nature of hormone

   c)ratios of the soil components d)all the previous

❖ Give reason:

1-PH meter is more accurate than PH test paper tape.

……

2-The presence of a pipette supported with a sucking tool in the chemistry lab.

……

❖ Correct the underlined word

✓ Conical flask is used to prepare solution of accurately known concentration.

……..

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❖ *Mention one use of:*

A. Measurement

……

B. Digital balance

……

C. Beakers

……

D. Physical chemistry

……

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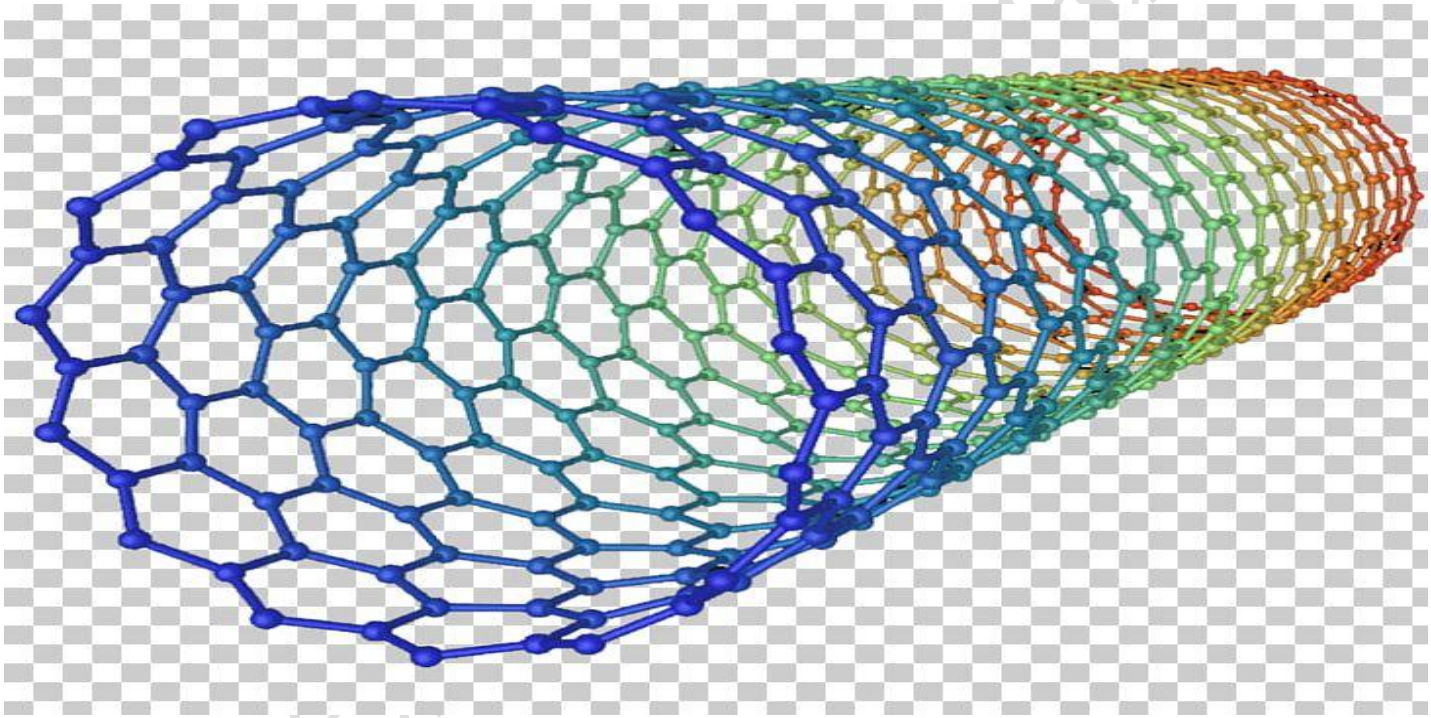
Unit One

Chapter 2



Nanotechnology and chemistry

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Nanotechnology:

Nano ---------- derives from Greek word Nanos and means dwarf or very small

Technology ---------- applied application of knowledge in certain field.

Nanotechnology

It is the technology of very small substances and it specialized in treating the substance on Nano measure to produce new, useful, and unique properties.

The Nano is a unique measuring unit:

1 milli = 1x10-3m

1 micro = 1x10-6m

1Nano = 1x10-9m (1 Nano = one part of a billion part of meter)

❖ Why the Nano scale is unique in measurement?

- ✓ The properties of substance as (color, transparency, ability to conduct heat and electricity
- ✓ Speed of chemical reaction, toughness, elasticity,….) change completely in Nano scale.
- ✓ The substance gain new and unique properties.(prop. Change with changing Nano volume).

✓ Nano substances can be used in new and uncommon applications.

Critical Nano volume

The volume in which the unique Nano properties of the substance appear and is located between (1-100 nm).

* So the properties of substances in Nano scale is **volume dependent properties.**

Examples on substances in Nano scale

Nano gold

- The gold is ***yellow*** in color and bright in normal scale
- Nano gold takes ***different colors*** according to their Nano volume (It may be red, green , orange and blue). Because the reaction of Nano gold with light is different from reaction of gold in macro volume.

Nano gold

- The ***hardness*** of nano copper is more than its hardness in macro measurement

The speed of reaction in Nano scale:

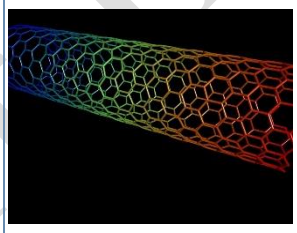
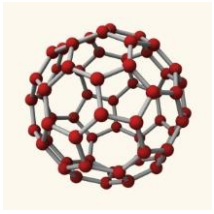
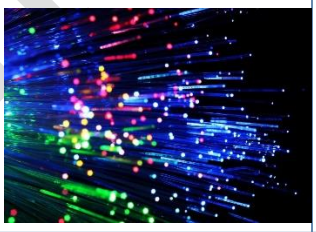
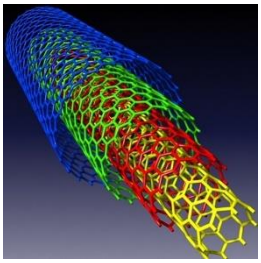
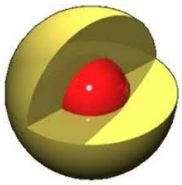
- In the Nano volume of the substance, the ratio ***increases*** between the surface area to volume so the number of atoms exposed to reactions increases so the speed increase and the substances gain new

* When substance changes from macro measurement to nano measurement surface area increases while volume remains constant

Nanochemistry

It is the branch of Nano science , it deals with chemical applications Of Nano substances.

Nano substances can be classified according to the dimensions into:

Type 1	One dimensional Nano substances	Two dimensional Nano substances	Two dimensional Nano substances
Defination 2	They are nano Substance with one Nano dimension less than 100 nm	They are Nano substances with two dimensions each of them less than 100 nm.	They are nano substances with three dimensions Each of them less Than 100 nm.
Examples 3	Thin films	Uni carbon Nano tube 	Bucky ball C60 
	Nano wires and fibers 	Multi carbon nano tube 	Nano shell 

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Uses	***Thin films*** are used in * Painting surfaces to protect them from rust. * Packing food Products to protect them from getting spoiled or rotting. ***Nano wires*** are used in electrical circuits. ***Nano fibers:*** are used in production of water filters	***Carbon Nano tubes*** Are * Good conductors of electricity than copper. * Good conductors of heat than diamond * Stronger and lighter than steel due to powerful bond between its molecules. * Connected easily to protein so they can be used in making biological sensor devices which are sensitive to certain molecules.	***Bucky ball C60*** Used as * Carrier for medicine in the body. **Due to its hollow structure It can match with a molecule of medicine** But its outer part resist the reaction of the medicine with other molecules in the body.

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Applications on Nano technology

Medical field

- The early diagnosing of diseases and picturing organs and tissues.
- Deliver medicine to the infected tissues and cells which increases the chances of healing and reduce harmful effects.
- Producing very minute devices for dialysis that can implanted in the body.
- Producing Nano robots that sent into blood streams and remove blood clots from veins without surgical interferences.

Energy field

- Produce solar cells using Nano silicon that has high ability to transform energy without leakage of heat energy.
- Producing Hydrogen fuel cells that are low in cost and high on performance.

Agricultural field

- Identify bacteria in nutrients and preserving food.
- Improve nutrients , pesticides and medicines for plants and animals.

Industrial fields

- Producing invisible Nano molecules that acquire glass and ceramic property of self cleaning.

- Producing Nano substances to purify ultraviolet rays in order to improve sun block cosmetics and creams.
- Producing a Nano wrapping technology in the form of paints and sprays that work to form layers of coverings that protect the screens of electrical devices from scratching.
- Producing repellent tissues for stains and distinguished with self-cleaning.

Communications field

- Producing wireless Nano devices, mobiles, and satellites.
- Decreasing the size of the transistors.
- Producing electric chips that are distinguished with a high storage capability.

Environmental fields

- Producing Nano filters that work on purifying the air, water, solving the problem of nuclear wastes and removing the dangerous elements from industrial wastes.

sheet review

Harmful effects of nanotechnology

Medical effects

- Very minute nano particles may enter the body of human or animal through cell membrane of skin or lungs causing diseases.

Environmental fields

- During production of Nano substances some wastes may be suspended in the air, water and soil causing pollution.

Social effects

- It may cause social inequality between rich countries and developed countries.

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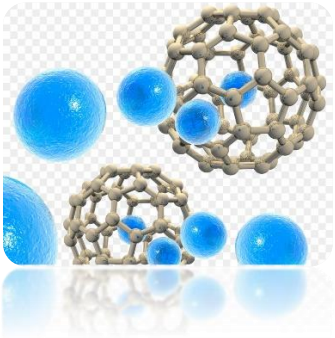
Chapter 2



❖ *Write the scientific term:*

a) The science which is interested in studying the chemical structure of the parts of the cell.

(……..)

b) Substances have two dimensions less than 100 nm.

(……..)

c) The measuring unit that equals one part per billion from the meter.

(……..)

❖ *Choose the correct answer:*

1- The reason of the new unique properties of the nano substances is the very large ratio between ..... and volume.

a) surface area b) density c) mass d) length

2- All the following are one-dimensional Nano substances except……

a) Thin films b) nano wires c) nano fibers d) nano shell

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3- Nnaometer equals …… meter.

a)1×10^{9} b)1×10 c)1×10^{-3} d)1×10^{-9}

4- .....is used as a carrier for medicine.

a) Nano robots b) Nano silicon c) Bucky ball d) carbon nano tube

❖ *Give reason for:*

- The bucky ball is denoted by C60.

  (……..)

- Solar cells using Nano silicon is better than normal solar cells.

  (……..)

- The effectiveness of using bucky ball as carrier for medicine.

  (……..)

❖ *Define:*

* Critical nano volume
(……..)

❖ *Give one use:*

- Nanotechnology in agriculture field.
  (……..)

❖ *Compare:*

- ✓ One, two, three dimensional substances according to (definition, example, uses)

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Unit Two

Chapter 1

Quantitative Chemistry

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Part (1): Ionic equations

The following table shows the valency of some metals:

Element Monovalent Valency (+1)	Element Divalent Valency(+2)	Element Trivalent Valency (+3)
• Lithium (Li) • Sodium (Na) • Silver (Ag) • Potassium (K)	• Mercury (Hg) • Magnesium (Mg) • Calcium (Ca) Lead (Pb) • Iron (Fe) Copper (Cu)	• Aluminum (Al) • Iron (Fe) • Gold (Au)

Table of atomic groups:

Atomic group	Symbol	Valency	Atomic group	Symbol	Valency
Hydroxide	OH^-	-1	Sulphate	SO_4^{-2}	-2
Nitrate	NO_3^-	-1	Carbonate	CO_3^{-2}	-2
Nitrite	NO_2^-	-1			
Bicarbonate	HCO_3^-	-1	Phosphate	PO_4^{-3}	-3
Ammonium	NH_4^+	+1			

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Chemical equation:

A group of chemical symbols and formulas of the reactants and products. They

connected by an arrow between them that express the direction of this reaction and carry the reaction condition.

$$2Mg_{(s)} + O_{2\,(g)} \xrightarrow{\Delta} 2MgO_{(s)}$$

► The equation includes the physical states written at the bottom left of the chemical symbols.

Solid	• s
Liquid	• l
Gas	• g
Aquenous Solution	• aq

The equation must be balanced. (G.R)
To achieve the law of mass conservation.

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Example: Try to balance these reactions:

1) $H_2 + O_2 \longrightarrow H_2O$
2) $N_2 + H_2 \longrightarrow NH_3$

Answer:

1) $2H_2 + O_2 \longrightarrow 2H_2O$
2) $N_2 + 3H_2 \longrightarrow 2NH_3$

Ionic equations:

It is the chemical equation in which reactants and products are written in the form of ions.

1) Dissolving equations:

As dissolving sodium chloride in water

$NaCl_{(s)} \xrightarrow{water} Na^+ + Cl^-$

2) Neutralization reaction:

It is the reaction between acid and base to produce salt and water.

Example:

Reaction between sulphuric acid and sodium hydroxide.

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

$$2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2Na^+_{(aq)} + 2OH^-_{(aq)} \longrightarrow 2Na^+_{(aq)} + SO_4^{-2}{}_{(aq)} + 2H_2O_{(l)}$$

$$2H^+_{(aq)} + 2OH^-_{(aq} \longrightarrow 2H_2O_{(l)}$$

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3) The ionic equation for precipitation reaction:

As precipitation of silver dichromate on adding potassium dichromate solution to silver nitrates solution.

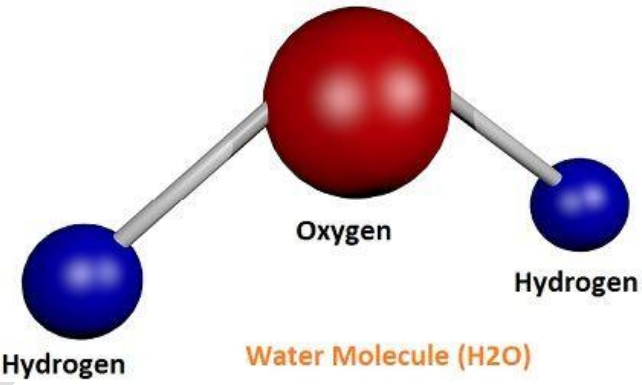
$$K_2Cr_2O_{7(aq)} + 2AgNO_{3(aq)} \longrightarrow 2KNO_{3(aq)} + Ag_2Cr_2O_{7(S)}$$

$$2K^+_{(aq)} + Cr_2O_7{}^{2-}_{(aq)} + 2Ag^+_{(aq)} + 2NO_3{}^-_{(aq)} \longrightarrow 2K^+_{(aq)} + 2NO_3{}^-_{(aq)} + Ag_2Cr_2O_{7(S)}$$

$$2Ag^+_{(aq)} + Cr_2O_7{}^{2-}_{(aq)} \longrightarrow Ag_2Cr_2O_{7(S)}$$

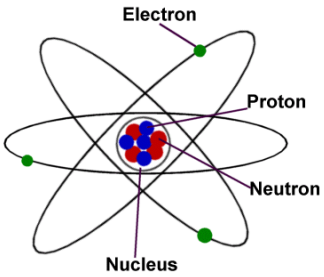
Molecule:

It is the smallest part of the substance that can be found in a single form and carry the properties of matter.



Atom:

It is the smallest building unit of the substance that can participate in chemical reactions.



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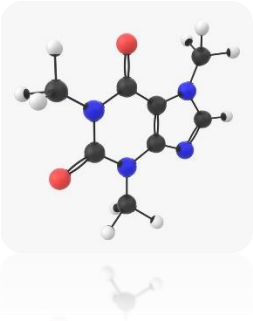
Chapter 1

Part 1



❖ Write the scientific term:

1) A group of chemical symbols and formula of the reactants and products (……..)

2) The chemical equation in which some or all reactants and products are written in the form of ions (…)

3) The reaction of an acid and base to form salt and water(…)

4) The smallest part of a substance that can be found in a single form and the properties of matter depends on it (…)

❖ Choose the correct answer:

1) The symbol (s) is written down the right of the chemical formula of which of the following: ……

a)NaCl b)H2O c)CO2 d)H2SO4

2) The chemical equation describes……

a)products b)reactants c)reaction condition d)all the previous

3) reaction can be represented by the following ionic equation

$H^+ + OH^- \longrightarrow H_2O$

a)precipitation b)direct combination

c)neutralization d)dissolving

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4) The chemical equation should be balanced to achieve the law of……

a) Avogadro b)energy conservation c)mass conservation d)fixed ratios

❖ Give reason for:

1-The chemical equation should be balanced

……

❖ Express the following in the form of ionic equation:

1-Reaction between nitric acid and potassium hydroxide

……

……

……

2-Reaction between sodium chloride and silver nitrate

……

……

……

❖ Rewrite the following equations after balancing them:

1) $H_2S + SO_2 \longrightarrow S + H_2O$

……

2) $Mg_3N_2 + H_2O \longrightarrow Mg(OH)_2 + NH_3$

……

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❖ Express the following in the form of equation:

1-Reaction between sulphuric acid and zinc.

……

2-Magnesium and copper sulphate.

……

3-Reaction between sodium hydroxide and nitric acid.

……

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Part (2):The mole and molar mass

The Mole:

It is the amount of substance that contains Avogadro number.

- If the substance is in the form of **atoms** , the mass of one atom is called **atomic mass**It is very small and measured by **atomic mass unit (a.m.u.)**.
- If the atomic mass of carbon atom (C) = 12 a.m.u., then **one mole** of carbon atom = 12 **grams** of carbon atoms.
- If the substance is in the form of **molecules** , then the mass of one molecule is called **molecular mass .** It is equal the sum of atomic mass of atoms forming this molecule.

Molecular mass:

It is the sum of the atomic mass of the atoms forming the molecule.

Example:

Calculate the molecular mass of carbon dioxide (CO_2).If you know that the atomic mass of oxygen is 16 and carbon is 12.

Answer:

Molecular mass of CO_2 = (atomic mass of carbon) + (2 x atomic mass of oxygen)

$= (12) + (2 \times 16)$

$= (12) + (32) = 44$ a.m.u.

One mole of CO_2 = 44 g

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- If we use 44 g carbon dioxide, this means that you use one mole of it.
- If we use 22 g carbon dioxide, this means that you use half mole of it. And so on
- In ionic compounds the building units can expressed in formula unit not molecules. So ionic compounds have formula unit mass not molecular mass.

Example:

Calculate the formula unit mass for ionic calcium chloride (CaCl2). If you know that the atomic mass of calcium ion is 40 and chloride ion is 35.5 .

Answer:

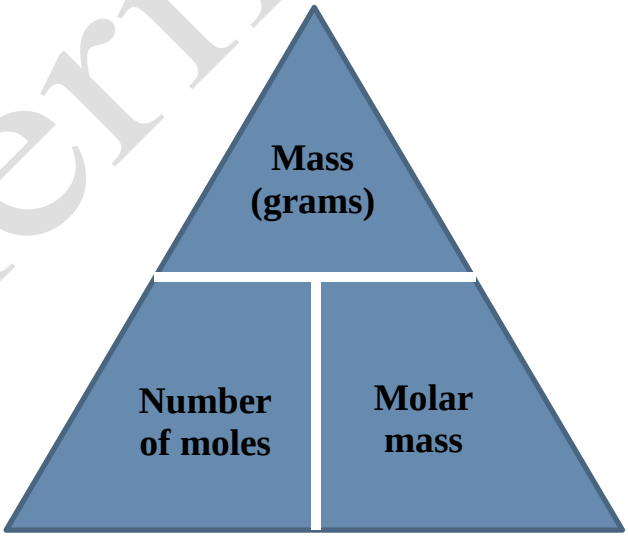
mass of CaCl2 = (mass of calcium ion) + (2 x mass of chloride ion)

= (40) + (2 × 35.5)

= (40) + (71) = 111 a.m.u.

One mole of CO2 = 111 g

$$\textbf{Number of moles} = \frac{\textbf{mass of substance (gram)}}{\textbf{Mass of one mole of this substance (g/mol)}}$$



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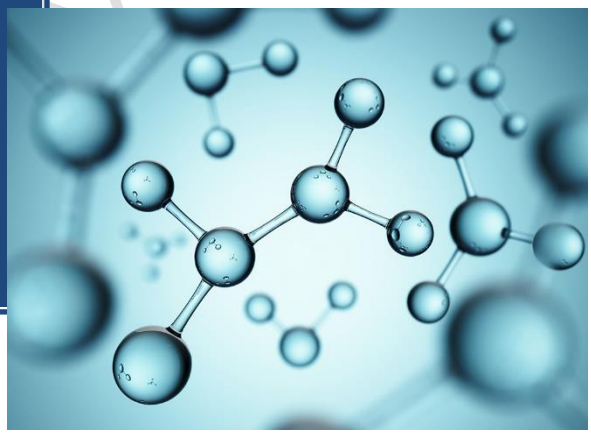
* The mass of a mole (molar mass) different from one matter to another.(G.R)
Due to the difference in composition from one matter to another.
The mole of molecules of monatomic element is different from the mole of the same element if it is diatomic.
*The molar mass of oxygen molecules = 16 × 2 = 32 g
*The molar mass of oxygen atom = 16 × 1 = 16 g

→ There are elements with different molecular composition due to difference in their physical state as
- phosphorus in vapour state formed from four phosphorus atoms (P4), while in solid state it consists of one atom
-Sulphur in vapour state formed from eight sulphur atoms (S8), while in solid state it consists of one atom



Calculation of the mass of reactants and products:

Example:

Calculate the mass of magnesium needed to react with excess amount of oxygen to produce 160g of magnesium oxide. [Mg = 24, O=16]

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Answer:

2Mg +	O2	⟶	2MgO
2moles			2 moles
2x24=48g			2(24+16)=80g
???			160g

Mass of magnesium= $\frac{160 \text{ x } 48}{80} = 96\ g$

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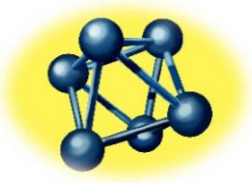
Chapter 1

Part 2



❖ Write the scientific term:

1-The sum of masses of atoms in one molecule of an element or a compound.

(…….)

❖ Choose the correct answer:

1-The molar mass of potassium sulphate is..... g [K=39, S=32, O=16]

a)147 b)135 c)130 d)150

2-The molar mass of sulphur in its vapor state

is…….a.m.u [S=32]

a)32 b)64 c)256 d)265

3-The mass of 0.1 mol of sodium hydroxide equals.. g[Na = 23,O=16 , H=1]

a)0.04 b)0.4 c)4 d)40

❖ Problems:

1-Calculate the number of moles of calcium in 40 g of calcium [Ca=40]

……

……

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2-What is the mass of 0.2 mole of water [H =1 , O = 16]

……

……

……

3-find the mass of 5 mole of potassium carbonate.

[k=39,C=12,O=16,H=1]

……

……..

4-Balance the following equation:

$Na + H_2O \longrightarrow NaOH + H_2$ [Na = 23, O = 16, H=1]

Then calculate the mass of sodium hydroxide which is produced from the reaction between 1 mol sodium with water.

……

……

5-Find the mass of calcium oxide produced from the thermal ecomposition of 50 g of calcium carbonate [Ca = 40 , C = 12, O = 16]

……

……

……

6-Find the number of moles of hydrogen gas needed to produce 0.18 g of water

……

……

……

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Part (3): The mole and Avogadro's number and volume of gases

The mole and Avogadro's number:

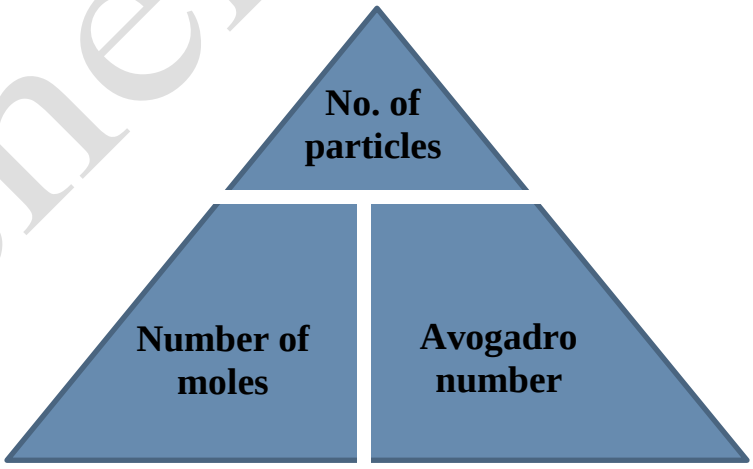
Avogadro reached that the number of atoms, molecules or ions found in one mole is a constant number whatever the form of substance.

Avogadro number = 6.02 × 10^{23}

Avogadro number

It is the number of atoms , molecules or ions found in one mole of the substance and equals 6.02 × 1023 (atoms, molecules or ions).

$$Number\ of\ mole = \frac{\text{number of particles}}{\text{Avogadro number}}$$



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Exercise 1:

Calculate the number of molecules of 2 mol of CO2 gas.

Answer:

Number of molecules = number of moles × Avogadro number

= 2 × 6.02 × 1023 = 12.04 × 1023 molecules

Exercise 2:

Calculate the number of carbon atoms found in 50 g of calcium carbonates

[Ca = 40, C = 12,O = 16]

Answer:

1 mole of calcium carbonate CaCO3 = 40 + 12 + (16 × 3) = 100 g

1 mole CaCO3 $\xrightarrow{\text{contains}}$ 1 mol of carbon atoms

100 g CaCO3 $\xrightarrow{\text{contains}}$ (6.02 × 1023) atoms

50 g CaCO3 $\xrightarrow{\text{contains}}$ × carbon atoms

$x = \frac{(6.02 \times 10^{23} \times 50)}{100}$ =3.01 × 1023 atom

Exercise 3:

Calculate the number of magnesium oxide molecules produced from reaction of 24 grams of magnesium with excess amount of oxygen.

[Mg = 24]

Answer:

2Mg + O2 ⟶ 2MgO

2moles ⟶ 2 moles

2 x 24= 48g ⟶ 2x 6.02 x 1023

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24 g ⟶ ??

Number of magnesium oxide molecules= $\frac{24 \times 2 \times 6.02\text{x}10\text{^}23}{48} = 6.02 \times 1023$

molecules.

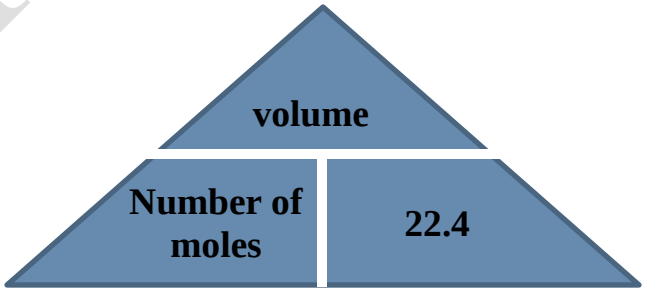
The mole and the volume of gas:

- ***Solid or liquid matter has a definite volume.***
- ***The volume of gas equal the volume of the container it occupies***
- ***The mole of any gas in standard temperature and pressure (STP) occupies a certain volume =22.4 liters.***

(STP) means

- ✓ Temperature equals 273 k or 0o c
- ✓ pressure = 760 mmHg (normal atmospheric pressure = 1 atm.p)
- ✓ Concentration = 1 molar

$$\textit{Number of mole} = \frac{\textbf{volume}}{\textbf{22.4 L}}$$



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Example 1:

Calculate the volume of 3 moles of oxygen gas

Answer:

Volume = number of moles × 22.4 = 3 × 22.4 = 67.2 L

Example 2:

Calculate the volume of oxygen needed to produce 90 g of water by reacting with an excess amount of hydrogen at the standard temperature and pressure (STP) [H = 1 , O = 16]

Answer:

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O(l)$$

1 mol ⟶ 2 mol

22.4L ⟶ 2[(2 × 1) + 16] = 36 g

?? ⟶ 90 g

$$\text{Volume of oxygen} = \frac{22.4 \times 90}{36} = 56 \text{ L}$$

Avogadro Hypothesis:

Equal volume of different gases contain the same number of molecules under the same standard temperature and pressure (STP).

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	Ne	O_2	Co_2
Volume	22.4L	22.4L	22.4L
Pressure	1 atm	1 atm	1 atm
Temperature	273 k	273 k	273 k
Quality	1 mole	1 mole	1 mole
Mass	40.0 g	32.0 g	28.0 g

Avogadro Law:

At constant temperature and pressure the volume of gas is directly proportional to its number of moles

Limiting reactant

It is the reactant which is completely consumed during chemical reaction

Example:

When magnesium reacts with oxygen according to the equation

$$2Mg + O2 \longrightarrow 2MgO$$

What is limiting reactant when 32 g of oxygen reacts with 12 g of magnesium?

[Mg = 24 , O=16]

$2Mg \longrightarrow 2MgO$	$O_2 \longrightarrow 2MgO$
2moles 2moles	1 moles 2 moles
2×24=48g 2(24+16)=80g	32 g 80 g
12g ??	32 g ??
Mass of magnesium oxide=20 g	mass of magnesium oxide = 80 g

Limiting reactant is magnesium.

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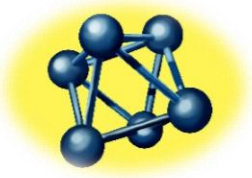
Chapter 1

Part3



❖ Write the scientific term:

1- The number of atoms, molecules or ions which are found in one mole of the substance.
(……..)

2- Equal volume of different gases at constant temperature and pressure contain equal number of molecules.
(……..)

3- The reactant which is completely consumed in the reaction.
(……..……)

4-The quantity of substance that contain Avogadro number of particles.
(……..)

❖ Choose the correct answer:

1- The mole of ammonia gas NH3 contains…….
a)3 mol of hydrogen molecules b)3 mol of hydrogen atoms
c)3 mol of hydrogen ions d)1 mol of nitrogen molecules

2-The mass of 3.0 × 1023 atoms of sodium is ……g [Na = 23]
a)0.5 b)11.5 c)23 d)45

3- When 1 mol of sodium chloride is dissolved in water, the total number of ions

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equals……

a) Avogadro's number b) 2 × Avogadro's number

c)3 × Avogadro's number d) 4 × Avogadro's number

4-The mass of 44.8 L of ammonia gas at STP is g [N = 14, H=1]

a)2 b)17 c)0.5 d)34

❖ Give reason for:

1-The equal masses of different element don't contain the same number of atoms

……

2-One liter of any gas contains the same number of molecules at STP.

……

❖ Problems:

1-Calculate the number of atoms in 0.5 mole of sodium. [Na = 23]

……

……

2-In the following equation

$4Al + 3\ O_2 \longrightarrow 2Al_2O_3$

a) Find the number of Oxygen atoms needed to react with 5.4 g of aluminum

……

……

b) Mass of oxygen needed to react with 0.6 mol of aluminum.

……

……

……

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3-Find the volume of 3.01 × 1023 molecules of CO2 gas at STP.

[C=12, O=16]

……

……

……

4- Calculate the required volume of oxygen gas to produce 90 g of water, when it reacts with an excess amount of hydrogen gas at STP [H =1, O=16]

……

……

5- Calculate the volume of CO2 gas which is produced from the thermal decomposition of CaCO3 sample its mass equals 150 g according to the following equation [Ca =40, C = 12 , O =16]

CaCO3 $\longrightarrow$ CaO + CO2

……

……

……

6-Arrange the following values ascending according to the volume at STP

a)22.4 L of N_2 b)3.2 g of O_2

c)0.9 mol of NO_2 d)3.01 × 10^{23} molecules of CO [O = 16, N=14, C=12]

……

……

……

7-Calculate the number of carbon atoms found in 50 g of calcium carbonate. [Ca=40 , C =12, O=16]

……

……

……

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8-Calculate the mass of calcium carbonate needed to produce 11.2 liter of carbon dioxide according to the following equation

$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

……

……

……

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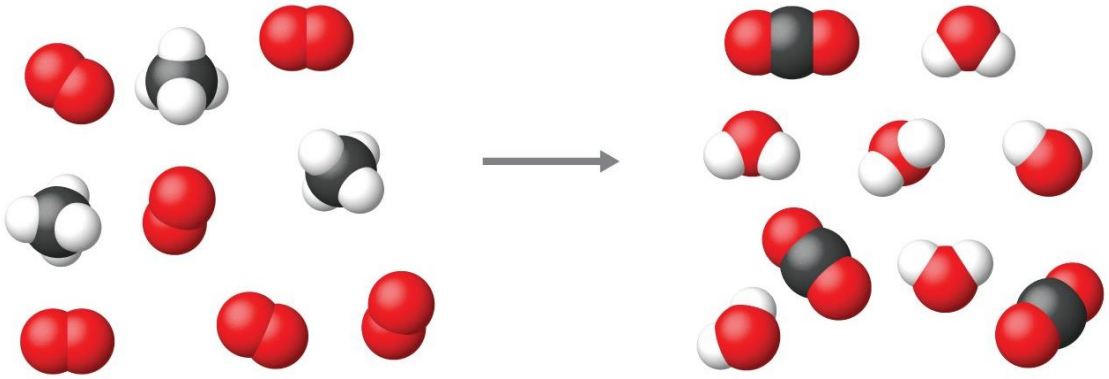
Unit Two

Chapter 2



Calculation of Chemical Formula

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Part (1): Calculation of Chemical Formula

Weight percentage:

It used to calculate the ratio of each component from the component of certain sample.

$$\textbf{Matter weight percentage} = \frac{\textbf{mass in the sample}}{\textbf{total mass of the sample}} \textbf{ x 100}$$

Example:

Calculate the weight percentage of nitrogen in one mole of ammonium nitrates fertilizers [N = 14 , H=1 , O=16]

Answer:

Molar mass of ammonium nitrate NH_4NO_3 = (14 + (1 ×4) +14 + (3 × 16))= 80 g Each one mole of ammonium nitrate contains 2 mol nitrogen = (2 × 14) = 28g

$$weight\ percentage\ of\ nitrogen = \frac{28}{80} \times 100 = 35\%$$

By calculating the weight percentage of oxygen and hydrogen. Weight percentage of oxygen = 60%

Weight percentage of hydrogen = 5%

- The sum of the weight percentage of a compound must be equal 100

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Example:

Calculate the mass of iron found in one ton (1000 kg) of hematite ore Fe_2O_3 , if you know that the weight percentage of iron is 58%

Answer:

58% means that each

100 ton ore $\xrightarrow{\text{contains}}$ 58 ton iron

1 ton $\xrightarrow{\text{contains}}$??? ton

$$x = \frac{1 \times 58}{100} = 0.58 \text{ ton} = 580 \text{ kg}$$

Example:

Calculate the number of moles of carbon in an organic compound containing only carbon and hydrogen. If you knew that the weight percentage of carbon in this compound is 85.71% and the molar mass of this compound is 28 g (C=12 , H= 1).

Answer:

There is 85.71 g carbon---------- in 100 g of the sample

So there is × g carbon---------- in 28g

X = (28 × 85.71) / 100 = 24 g

Number of carbon moles = 24/12 = 2 mol

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Another answer:

$$carbon\ mass = \frac{carbon\ weight\ percentage\ x\ molar\ mass\ of\ the\ compound}{100}$$

$$= \frac{85.71\ x\ 28}{100} = 24\ g = 2\ mol$$

Empirical formula:

A formula expressing the simplest ratio of true numbers between the atoms of elements which formed the compound.

Example:

The molecular formula of propylene is C_3H_6 ---------- That means that the molecule of propylene is formed of 6 atoms of hydrogen and 3 atoms of carbon with ratio of 6(H) : 3(C).

By simplifying this ratio to its true value the ratio becomes 2 (H) : 1 (C) so the empirical formula is CH_2

- Sometimes the empirical formula is similar to chemical formula like (carbon dioxide CO2) – (Nitric oxide NO)
- The empirical formula of two different compounds may be the same like acetylene C2H2 and benzene C6H6 . Both of them has empirical formula (CH)
- The empirical formula of the compound can be calculated in terms of weight percentage of elements that represent that mass of elements found in 100 g

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Example:

Calculate the empirical formula of a compound containing nitrogen with a weight percentage of 25.9 % and oxygen with a weight percentage of 74.1 % knowing that (N = 14 , O = 16)

Answer:

Number of moles

N	:	O	
$\frac{25.9}{14}$	:	$\frac{74.1}{16}$	
$\frac{1.85}{1.85}$	:	$\frac{4.63}{1.85}$	
1	:	2.5	*(x 2)*

The empirical formula is N_2O_5

Molecular formula:

Is a symbolic formula of the molecule of the element, or molecule or formula unit. It express the actual type and number of atoms or ions that form this molecule or unit.

$$\textit{Number of units of the emperical formula} = \frac{\textit{molar mass of the compound}}{\textit{molar mass of the emperical formula}}$$

Example:

Chemical analysis of acetic acid prove that it is formed from 40% carbon, 6.67% hydrogen , and 53.33% oxygen. If the molecular molar mass of it is 60 g find the molecular formula of the acid knowing that (C= 12, H=1, O=16)

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Answer:

	C	H	O
Number of moles	$\frac{40}{12}$	$\frac{6.67}{1}$	$\frac{53.33}{16}$
	3.33	6.67	3.33

Ratio = 1 : 2 : 1

Empirical formula is CH_2O

Molecular mass of empirical formula= 16 +(1 x2) + 12 = 30 g

Number of units of empirical formula = $\frac{60}{30}$ = 2

Molecular formula is $CH_2O \times 2 = C_2H_4O_2$

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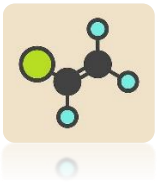
Chapter 2

Part 1



❖ Write the scientific term:

1-A symbolic chemical formula that represent the simplest whole number ration of atoms in an element . (…)

❖ Choose the correct answer

1. The percentage of aluminum in aluminum sulphate…….

[Al =27, S=32, O=16]

a) 36% b) 20.8% c) 15.78% d) 7.89%

2. CH3 is the empirical formula of……..

a) C3H6 b) C3H8 c) C3H7 d) C2H6

3. The molecular formula of a hydrocarbon compound which has an empirical formula C2H3 and its molecular mass is 81, is……

a)C4H6 b) C5H10 c) C6H9 d) C2H8

4. The number of empirical formula units of the compound C2H2O4 is

a)1 b)2 c)3 d)4

5. If the molecular formula of vitamin C is C6H8O6 then its empirical formula is……..

a)C3H4O6 b)C3H4O3 c)C6H4O3 d)C3H8O3

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❖ Give reason for:

1-The empirical formula does not represent the actual composition of a compound

……

……

2-Acetylene (C_2H_2) and aromatic benzene (C_6H_6) have the same empirical formula.

……

……

❖ Problems:

1. Calculate the number of moles of carbon and hydrogen atoms which are present in an organic compound contains only carbon and hydrogen atoms, knowing that its molar mass is 28 g /mol and the mass percentage of carbon is 85.7%

[C=12, H =1]

……

……

……

2. Calculate the molecular formula of a compound its molecular mass is 56 g and its empirical formula is CH_2

[C=12, H=1]

……

……

……

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3. The chemical analysis of butadiene compound has proved that it contains 55.8% carbon, 7.03% hydrogen, and 37.17% oxygen. Find its molecular formula, knowing that its molecular formula contains 2 units of its empirical formula.

……

……

……

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Part (2): Practical and theoretical yield

Practical product and theoretical product:
When we make a chemical reaction to obtain a certain substance the theoretical results that expected to get from the reaction is different from the produced substance practically (practically yield).

Theoretical yield:

It is the quantity of product calculated according to the chemical equation.

Practical yield:

It is the quantity of product that is actually produced from the reaction.

- The practically yield usually less than the calculated amount theoretically.

Due to

The product substances may evaporates.
Some of the product may clink on to the walls of of the reaction cylinder.
There are some side reactions (competitive reactions) that consume the product
4-The used substance may be not pure enough.

$$\textbf{Percentage of actual yield} = \frac{\textbf{practical yeild}}{\boldsymbol{Theoritical\ yeild}} \times \mathbf{100}$$

Example:

Methyl alcohol is produced under high pressure through the following reaction

$$CO\ (g) + 2H_2\ (g) \xrightarrow{\triangle} CH_3OH\ (l)$$

If 6.1 g of methyl alcohol is produced from a reaction of 1.2 g of hydrogen with abundance of carbon oxide, calculate the percentage of the actual yield (C= 12, O = 16, H=1)

Answer:

Molecular mass of $CH_3OH = 1\times4 + 16 + 12 = 32$ g

2mol of $H_2 \xrightarrow{\text{produce}}$ 1 mol of CH_3OH

4g ⟶ 32 g

1.2 ⟶ x g

$$X = \frac{32 \times 1.2}{4} = 9.6 \text{ g}$$

$$\text{Percentage of yield} = \frac{6.1}{9.6} \times 100 = 63.54\ \%$$

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Chapter 2
Part 2

❖ Write the scientific term:

1-The calculated quantity of products expected from given quantities of reactants.

(……..)

❖ Choose the correct answer:

1. The amount of the practical yield in the chemical reaction is always……..the theoretical yield

a)less than b)equal c)more than d)non of the previous

2- The compound which its molecule consists of 3 atoms of carbon, 6 atoms of hydrogen and 1 atom of oxygen its molecular formula is……..

a)(CH)3OH b)C6H3O c)(CH3)2CO d)(CH3)2O

❖ Problems:

1-Calculate the percentage of yield when 20 g of sodium chloride solution reacts with an excess amount of silver nitrate solution knowing that 45 g of silver chloride precipitated

……
……
……

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Unit Three

Chapter 1

Solutions and colloids

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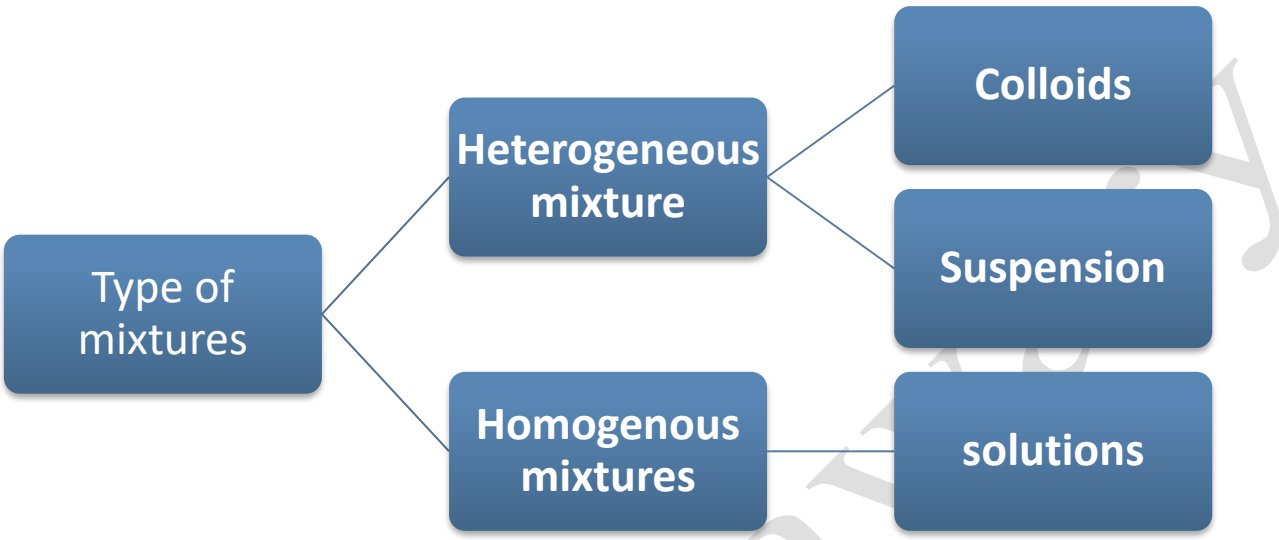
Part (1): Solutions



Solutions

They are homogenous mixtures in which you cannot distinguished its components by naked eye or by electronic microscope

Examples:

- ✓ Table salt solution in water

- ✓ Sugar in water
- ✓ cobalt (II)chloride in water

Colloids

They are heterogeneous mixtures that carry the properties of solution and suspension

Components can be distinguished by microscope.

Examples:

Milk -blood - aerosols -hair gel - mayonnaise emulsion

Colloids

They are heterogeneous solutions in which you can distinguish its components by your eye.

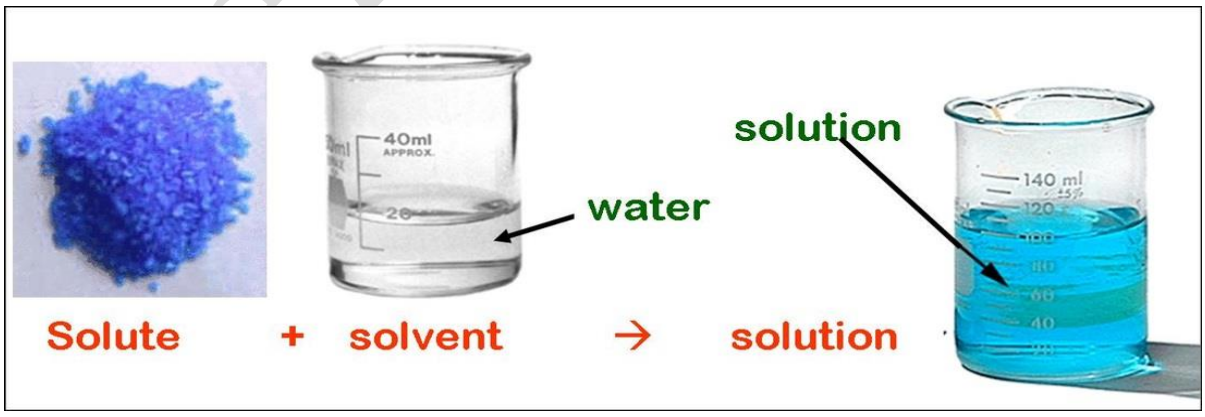
Examples:

- ✓ Table salt in kerosene
- ✓ sugar in kerosene
- ✓ cobalt (II)chloride in kerosene

Solutions

Solute + Solvent ⟶ Solution

(Small amount) (Minor component) **(Large amount) (Major component)**



Classification of solutions

According to

1) The physical state of solvent

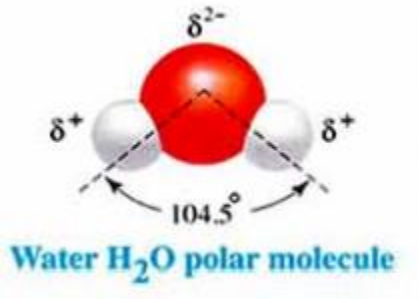
Some times the word solutions is connected with a liquid state of the substance. But solutions may be in gas or liquid or solid state

Type of solution	Solute state	Solvent state	Examples
Gas	Gas	Gas	Air – natural gas
Liquids	Gas	Liquid	Soft drinks – oxygen dissolved in water
	Liquid		Alcohol in water Ethylene glycol(anti-freeze)in water
	Solid		Sugar or salt in water
Solid	Gas	Solid	Hydrogen in platinum or palladium
	Liquid		Silver amalgam $Ag_{(s)}$ / $Hg_{(l)}$
	Solid		Alloy of nickel – chrome alloy

Water is a polar solvent:

Water is a polar solvent because the electro negativity of oxygen is higher than hydrogen.So oxygen carries a partial negative charge while hydrogen carries a partial positive charge

With angle 104.5^0 between them



Water H_2O polar molecule

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2) Ability to conduct electricity

Solutions are classified according to conduction of electricity into

Electrolyte

The substance in which it solutions or its molten state conduct the electric current by the free ion movement.

as (table salt solution) .

Non electrolyte

The substance in which its solution or its molten state do not conduct electricity because it doesn't have Free ions.

as (Sugar solutions – ethyl alcohol) in water

Electrolytes are classified into

Strong electrolytes

They have the ability to conduct electricity to large extent as it is completely ionized (all its molecules are dissociated into ions)

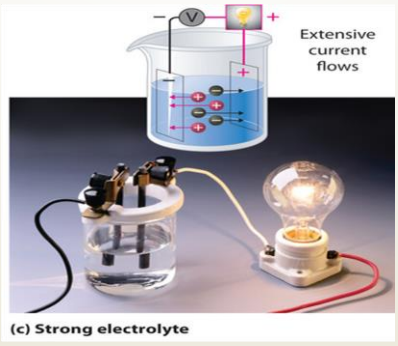
Examples:

Ionic compounds: as

- sodium chloride NaCl
- sodium hydroxide NaOH

Polar covalent compounds: as

- Hydrogen chloride solution but hydrogen chloride in gas state doesn't conduct electricity.



$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

Weak electrolyte

Conduct the electricity to weak extent as it is partially ionized (Small parts of its molecules are dissociated into ions)

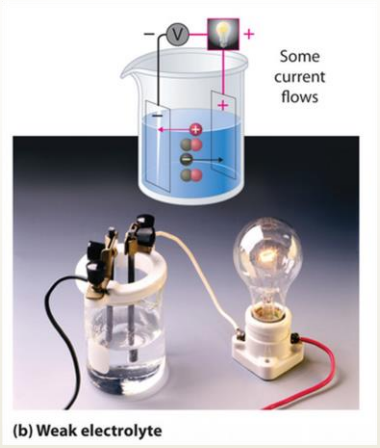
Examples:

Ionic compounds: as

- Ammonium hydroxide NH4OH

Polar covalent compounds: as

- Acetic acid CH3COOH

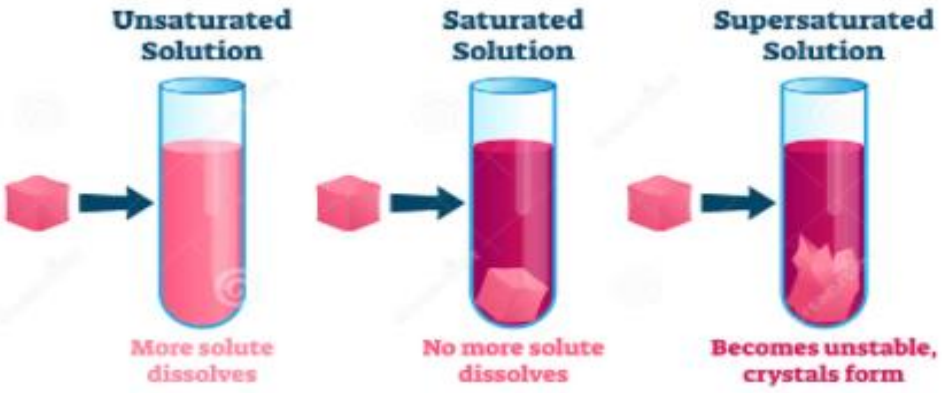


$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

3) Degree of saturation:

Classification of solutions according to

Unsaturated solutions	Saturated solutions	Super saturated solutions
• It is the solution at which the solvent accepts more solute at a certain temperature.	• It is the solution at which the solvent accepts more solute at a certain temperature.	• It is the solution that accepts more of the solute after reaching saturation by heating



How can you prepare a saturated solution from a supersaturated solution?

1. Cooling

Cool the saturated solution and leave it for a short time, the excess solute will be precipitated.

2. Crystallization

Put small crystals from the solute in the supersaturated solution and leave it for a short time, the solute molecules will precipitates as crystals on the surface of seeding crystals.

Dissolving process:

It is the process occurs when the solute decomposes or dissociate into negative and positive ions or into separated polar molecules. Each of them binds to the molecules of the solvent.

The mechanism of dissolving process

It's easy to dissolve:

- Ionic compounds (as sodium chloride) **in polar solvent**
- Polar covalent compound (as hydrogen chloride gas) **(as water)**

The speed of the dissolving process depends on:

- ✓ Surface area of the solute
- ✓ Stirring
- ✓ Temperature

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Solubility

Solubility:

It is the ability of solute to dissolve in a certain amount of solvent. Or it is the ability of solvent to dissolve certain amount of solute.

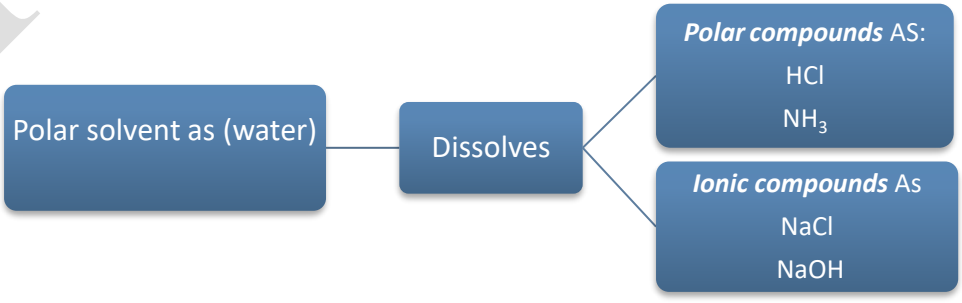
Degree of solubility:

It is the mass of solute by grams which dissolve in 100 grams of the solvent to form a saturated solution at standard conditions.

Factors affecting the solubility

1) The nature of solute and solvent:

Like dissoves like



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- Substances that easily dissolve in **water** are **ionic or polar covalent** compounds.

Give reason

Oil is insoluble in water.
Because oil is non polar while water is polar compound.
Oil is soluble in benzene.
Because both of them is non polar.
Sugar is soluble in water although sugar is non polar.
Because sugar molecules make hydrogen bond with water

2) Temperature:

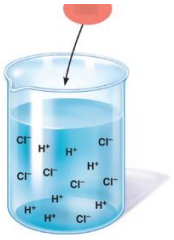
The solubility of most ionic substance increases with increasing the temperature.

Some properties of solution

- Particles cannot be distinguished by naked eye or by the electron microscope.
- Diameter of the particles is less than 1 nm
- Particles of solution are regularly distributed
- Particles don't scatter a beam of light passing through it.

Chapter 1

Part 1



❖ Write the scientific term:

1-Homogenous mixtures can't be distinguished neither by eye nor microscope.
(……)

2-The substance that exist in the largest amount within the solution.
(……)

3-The substance that exist in the smallest amount within the solution.
(……)

4-The ability of an atom to attract the electrons of the chemical bond toward itself.
(……)

5-Substances are completely ionized in their solution.
(……)

6-Substances that conduct electricity to less extent.
(……)

7-The solution in which the solvent dissolves less amount of the solute at a certain temperature.
(……)

8-The solution which can be obtained from the saturated solution by heating.
(……)

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❖ Choose the correct answer:

1-Blood and milk are examples of ……

a) Liquid solutions b) solid solutions c) colloids d) suspensions

b) 2-All the following substances are incompletely ionized except…….

a) CH_3COOH b) NH_4OH c) NaOH d) H_2O

3 ..... is a solid solution of solid in solid

a) Naphthalene in air b) sugar in water
c) Nickel chrome alloy d) Blood

❖ Give reasons for:

1-Oil does not dissolve in water but dissolves in benzene
……
……

2-Hydrochloric acid is a strong electrolyte.
……
……

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Part (2): Concentration of solutions

- You can change the concentration of solution by changing the amount of solute in a solvent.
- The solution will be concentrated if the amount of solute is large (but not larger than solvent).
- The solution is said to be diluted when the amount of solute is small
- We express the concentration of solutions by

(Percentage – molarity – molality)

Percentage

$$\text{Percentage (volume – volume)} = \frac{\textbf{\textit{solute volume}}}{\textbf{\textit{solution volume}}} \times 100$$

$$\text{Percentage (mass – mass)} = \frac{\textbf{\textit{solute}}\ \text{mass}}{\textbf{\textit{solution}}\ \text{mass}} \times 100$$

Solution mass = (solute mass + solvent mass)

Molarity

It is the number of solute moles that dissolved in one liter of solution

Unit : (Mol / L) or molar (M)

$$\textbf{Molarity} = \frac{\textbf{\textit{Number of solute moles}}\ (mol)}{\textbf{\textit{solution volume}}\ (L)}$$

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Example:

Calculate the molarity of sugar cane solution C12H22O12 in water, if you knew that the mass of the dissolved sugar is 85.5 g in a solution volume of 0.5 L (C = 12, H=1, O=16).

Answer:

Molar mass of sugarcane = (12 × 12) + (1 × 22) + (12 × 16)=358 g/mol

Number of moles = mass / molar mass = (85.5) / (358) = 0.24 mol

$$\text{Molarity} = \frac{Number\ of\ moles\ (mol)}{solution\ volume\ (L)} = \frac{0.25}{0.5} = 0.47 \text{ mol/liter}$$

Molarity

It is the number of solute moles in one kilogram of solvent

Unit : (Mol / Kg)

$$\textbf{Molality} = \frac{\boldsymbol{Number\ of\ solute\ moles\ (mol)}}{\boldsymbol{solvent\ mass\ (kg)}}$$

Example:

Calculate the molality of a prepared solution by dissolving 20 g of sodium hydroxide in 800 g of water, knowing that (Na = 23 , H = 1, O= 16)

Answer:

Molar mass of sodium hydroxide (NaOH) = (23 + 16 +1) = 40 g /mol

Number of moles = mass / molar mass = 20/40 =0.5 mol.

Mass of solvent by kilogram = 800/1000 = 0.8 kg

$$\text{Molality} = \frac{Number\ f\ moles\ (mol)}{solvent\ mass\ (kg)} = \frac{0.5}{0.8} = 0.625 \text{ mol / kg}$$

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Chapter 1

Part 2

❖ Write the scientific term:

1- The number of grams of solute dissolves in 100 g of the solvent to form a saturated solution at STP. (….....)

2- The number of moles of a solute dissolved in one liter of solution. (……..)

3- The number of moles of solute dissolved in one kilogram of solvent. (……..)

❖ Choose the correct answer:

1- The molality of a solution expressed by……..

a) mol/L b) g/L c) mol/kg d) Kg/L

2- The molality of solution formed by dissolving 5 mol of sodium chloride in 10 L of solution is.....M

a) 0.5 b) 0.05 c) 50 d) 5

3- When 20 g of sodium hydroxide are dissolved in an amount of water to get 0.25L of a solution the concentration will be……..

a) 0.08 mol/L b) 0.08kg/L c) 2m d) 2M

4- If 18 g of glucose $C_6H_{12}O_6$ is dissolved in 100 g of water. The concentration of the resulting solution is..... [C=12, H=1 , O=16]

a) 1m b) 0.01 M c) 15.25% d) a and c

5- One liter of a solution of 0.25 M sodium hydroxide contains.....of NaOH [Na = 23, O=16, H=1]

a) 4 mol b) 0.25 mol c) 10 g d) b and c

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❖ Problems:

1- Calculate the (volume-volume) percentage of a solution which formed by dissolving 15 ml of oil in 50 ml of benzene.

……

……

……

2- Calculate the (mass-mass) percentage of a solution formed by dissolving 0.5 mol of NaOH to 80 g of water. [Na=23, O=16 , H =1]

……

……

……

3- Calculate the molarity of a solution whose volume is 3 L and contains 0.5 mol of silver nitrate.

……

……

……

4- Calculate the concentration of a solution formed by dissolving 5.6 g of potassium hydroxide in an amount of water to form 500 ml of a solution [K=39, O=16, H=1]

……

……

……

5- Calculate the molality of a solution prepared by dissolving 1 mol of calcium chloride in 271 g of water

……

……

……

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6- 53 g of sodium carbonate are dissolved in 400 g of water. What is the molality of this solution ? [Ca = 23 , C =12 , O=16]

……

……

……

7-What is the mass of glucose ($C_6H_{12}O_6$) required to dissolve in 563 g of ethanol to prepare 2.4 x 10^{-2} m of solution? [C = 12, O = 16, H = 1]

……

……

……

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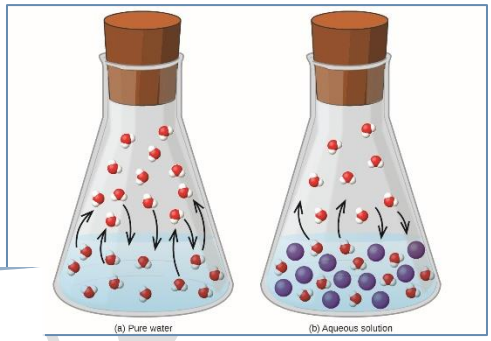
Part (3): Collegative properties of solutions

The properties of a pure solvent differ from its properties by dissolving a solid non volatile substance in it. These properties as (vapor pressure, boiling point, freezing point)



Vapor pressure:

It is the pressure that exerted by a vapor in dynamic equilibrium with its liquid inside a closed container at a constant temperature and pressure

Difference in vapor pressure of pure

Pure solvent

- The surface molecules which exposed to vaporization process are the **solvent molecules only**.
- The force that has to be overcome is the attraction force between the solvent molecules with each other.

Solution

- The surface molecules are the **solvent molecules** and **solute molecules** so the number of solvent molecules which exposed to vaporization process **decrease**
- The force that has to be overcome is the attraction force between solvent and solute molecule that is larger than the attraction between solvent molecules

Boiling point:

It is the temperature in which the vapor pressure of the liquid equals the atmospheric pressure.

Measured boiling point:

The temperature at which the vapor pressure of the liquid equals the pressure exerted or acted on it.

- It can be used as indicator for purity of solvent.

Pure water boils at 1000c while salty water causes increasing in the boiling point.(G.R)

Because by adding salt to water the vapor pressure of the solution decrease so the solution needs more energy until its vapor pressure equals to atmospheric pressure to boil.

Boiling point increases by increasing the number of moles of ions in the solution.

Boiling point of 0.2M sodium chloride solution is equal to boiling point of 0.2M potassium nitrate solution.(G.R)

Because both of them produce the same number of moles of ions in the solution.

Boiling point of sodium carbonate is higher than boiling point of sodium chloride with same concentration.(G.R)

Because the number of moles of ions in Na2CO3 is higher than that of NaCl.

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Freezing point:

- ✓ Freezing point is opposite to boiling point.
- ✓ Freezing point of solution is less than freezing point of pure solvent.(G.R)
- ✓ Decreasing in Freezing point is inversely proportional to the number of
- ✓ dissolved solute in the solutions.
- ✓ Freezing point of sugary solution (not ionized into ions) is -1.86 0C.
- ✓ Freezing point of sodium chloride (produce two ions) is (2 x -1.86) = -3.720C.
- ✓ Salt is added to snow – covered roads in cold places.(G.R)

Freezing point of solution is less than freezing point of pure solvent.(G.R)

Because the attraction force between solvent and solute increase so number of solvent molecules that will change into solid state on freezing decrease.

Salt is added to snow – covered roads in cold places.(G.R)

Because the Because salt decrease the freezing point of water so water will not easily change to snow and this prevent cars from skidding and decrease the number of accidents.

Suspension:

They are heterogeneous solutions in which you can distinguish its components by your eye.

- The suspended particles precipitate if it lift for a short time without shaking.
- The diameter of its particles is larger than 1000 nm.
- The suspended particles can be seen by eye.
- The suspended particles can be separated by filtration as filter paper hold the suspended particles while water pass through paper.
- **Examples** (Sand in water – Chalk powder in water).

Colloids:

They are heterogeneous mixtures that carry the properties of solution and suspension.

- The dispersed particles don't precipitate if they are left for a short time without shaking.
- The dispersed particles diameter is from 1- 1000 nm
- The dispersed particles can be seen by electronic microscope only
- The dispersed particles cannot be separated by filtration.
- The shape depends on its concentration

- **Concentrated colloids appears as milk**
- **Diluted colloids appears clear**

sherif away

Dispersed phase	Dispersed medium	Examples
Gas	Liquid	Some types of creams – whipped egg
	Solid	Sweat made of sugar and egg white
Liquid	Gas	Aerosols
	Liquid	Milk – mayonnaise
	Solid	Hair gel
Solid	Gas	Dust in air particles
	Liquid	Pigment – blood – starch in hot water

There is no gas-gas colloidal system.(G.R)
Because mixed gases are homogenous mixture

Preparation methods for colloids

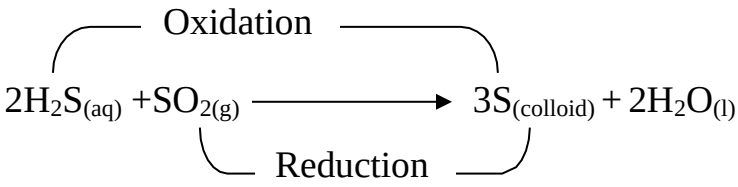
Dispersion method:

- The substance is crushed into small particles until its size reaches the size of colloid particles.
- Then added to the dispersed medium with stirring

As (Starch in hot water)

Condensation method:

- The small particles are collected together into larger particles have the volume of the colloid particles by chemical reactions as (oxidation – reduction – hydrolysis)with each other.



Chapter 1

Part 3

❖ Write the scientific term:

1- The pressure that vapor affects on the liquid surface at equilibrium with the liquid inside a closed container at a closed container at constant temperature and pressure. (… .....)

2- The temperature at which the vapor pressure of the liquid equals to the atmospheric pressure (….....)

3- The heterogeneous mixture in which the diameter of its particles is larger than 1000 nm (….....)

❖ Choose the correct answer:

1- The attraction forces between the solvent molecules and solute molecules in the solution is…… the attraction force between solvent molecules and each other in the pure solvent.

a) stronger than b)weaker than c)equal d)none of the previous

2-The vapor pressure of the solution is .....the vapor pressure of the pure solvent which forms it.

a)equal b)higher than c)lower than d)none of the previous

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3-Dissolving 1 mol of… ..... in 1 L of water has the largest effect on decreasing the vapor pressure of water

a) KBr b)$C_6H_{12}O_6$ c)$MgCl_2$ d)KOH

4-If the freezing point of an aqueous glucose solution is ..... the freezing point of an aqueous solution of table salt when their concentrations are equal

a)equal b)half c)double d)three times

❖ Give reasons for:

- The vapor pressure of a solution is lower than the vapor pressure of its pure solvent.

……
……
……

- We can differentiate between the solution and colloids by using a beam of light.

……
……
……

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Unit Three

Chapter 2

Acids and bases

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Industries including acids

- ✓ Fertilizers
- ✓ Medicines
- ✓ Plastic
- ✓ Car batteries

Industries including bases

- ✓ Soap
- ✓ Detergents
- ✓ Dyes
- ✓ 4-Medicines

Natural and artificial products including acids or bases in their composition:

Product	Acids entering in its composition
Acidic plants (lemon – oranges – tomatoes)	Citric acid – Ascorbic acid
Dairy products (Milk – yoghurt)	Lactic acid
Soft drinks	Carbonic acid – phosphoric acid

Product	Bases entering in its composition
Soap	Sodium hydroxide
Baking soda	Sodium bicarbonate
Washing soda	Hydrated sodium carbonate

Properties of acids and bases

p.o.c	Acids	Bases
Taste	Sour taste	Bitter taste
Effect on litmus paper	Change the color of litmus into red	Change the color of litmus into blue
Reactions	With active metals to give salt of acid and hydrogen gas $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$ *With carbonate and bicarbonate to produce CO_2 $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$ *With bases to produce salt and water.	*With acids to produce salt and water. $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

Scientific Knowledge

Theories that describe acid and base

- ✓ Arrhenius theory
- ✓ Bronsted lowery theory
- ✓ Lewis theory

Arrhenius theory

Definition of acid

It is the substance that ionize or dissociate in water to give one or more hydrogen ions H+

$HCl_{(g)} \xrightarrow{Water} H^+_{aq} + Cl^-_{(aq)}$

$H_2SO_4\ (aq) \xrightarrow{Water} H^+_{aq} + HSO_4\ (aq)$

$HClO_4(aq) \xrightarrow{} {}^+_{aq} + ClO_4\ (aq)$

So acid is good conductor of electricity. And it increases the concentration of positive hydrogen ions in aquatic solutions.

Definition of base

It is the substance that ionize or dissociate into water to give one or more hydroxide ions OH-

$NaOH_{(S)} \xrightarrow{water} Na^+_{aq} + OH^-_{(aq)}$

$KOH_{(aq)} \xrightarrow{water} K^+_{aq} + OH^-_{(aq)}$

$Ba(OH)_{2\ (aq)} \xrightarrow{water} Ba^{+2}_{(aq)} + 2OH^-_{(aq)}$

So base is good conductor of electricity. And it increases the concentration of negative hydroxide ions in solution.

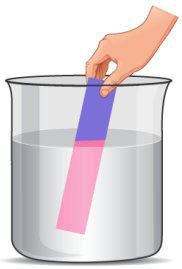
Reaction between acid an base

- It produces salt and water.

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

- The neutralization reaction

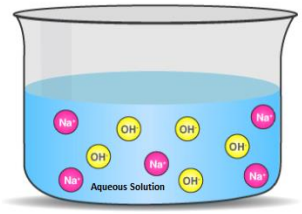
$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$



Arrhenius acids

Observations on Arrhenius theory

- Carbon dioxide doesn't contain a source of positive hydrogen ion but is considered as acid.
- He said that acid must contain hydrogen ion and base must contain hydroxide group and it is not completely correct.



Ammonia

- In water give hydroxide ion while it is not Arrhenius base.

$NH_3 + H_2O \longrightarrow NH_3^+ + OH^-$

It neutralizes with acid

Bronsted Lowry theory

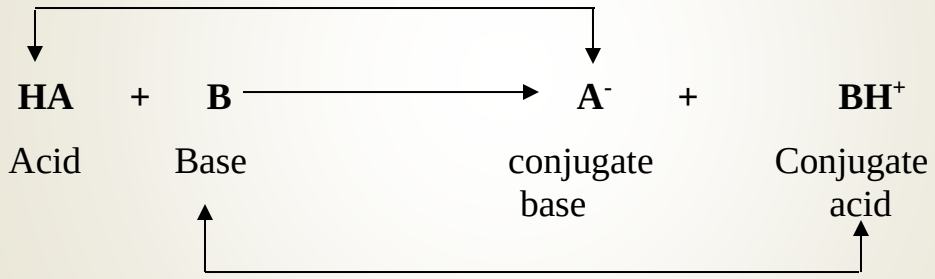
Definition of acid

- It is the substance that give the proton H+ (proton donor).

Definition of base

- I t is the substance that has the ability to accept the proton (proton acceptor).

reaction between acid and base



Examples

1) Hydrogen chloride and water

$HCl + H_2O \longrightarrow Cl^- + H_3O^+$

(acid) (base) conjugate base conjugate acid

2)Ammonia in water

$NH_3 + H_2O \longrightarrow OH^- + NH_4^+$

(base) (Acid) conjugate base conjugate acid

Definition of base

Conjugate acid

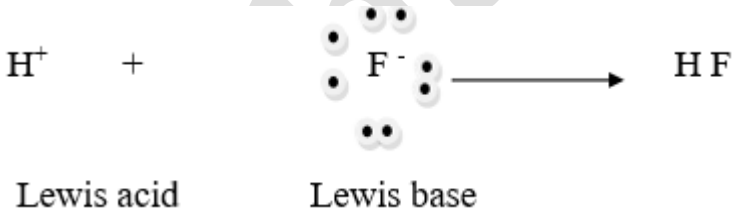
The substance that produced when base accepts a proton.

Conjugate base

The substance that produced when acid loses a proton.

Arrhenius theory

Definition of acid	Definition of base	Examples
• Substance that accept an electron pair or more	• Substance that donates an electron pair or more	• Reaction of hydrogen ion with fluoride ion



Comparison of acid and base in the three theories

Theory	Acid definition	Base definition
Arrhenius	H+ producer	OH- producer
Bronsted – Lowry	H+ donor	H+ acceptor
Lewis	Electron pair acceptor	Electron pair donor

Chapter 2

Part 1

❖ Write the scientific term:

1-A substance that dissolves in water to give positive hydrogen ions.
(……)
2-A substance that dissolves in water to give negative hydroxide ion.
(……)
3-The substance that is produced when a base accepts a proton.
(……)
4-The substance that donates an electron pair or more.
(……)
5-The substance that accepts an electron pair or more.
(……)

❖ Choose the correct answer:

1 ..... acid is found in acidic plants

a) phosphoric b) lactic c) citric d) carbonic

2-From the properties of acids……

a) Have a sour taste b) Slippery feel

c) Change the red litmus to blue d) all the previous

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3.....gas is evolved when the acids react with active metals

a) Oxygen b) Hydrogen c) Chlorine d) Carbon dioxide

4-According to Arrhenius theory the base is dissolved in water to form .....ions

a)CO_3^{-2} b)OH^- c)NH_4^+ d)H^+

5-The Bronsted Lowery acid is similar to Arrhenius acid because both of them contain……..

a)Lone pair of electrons b)hydrogen bond

c)Hydroxyl group d) (a) & (b)

6 .....theory depends on lone pair of electrons to define acid and base

a) Lewis b) Bronsted Lowry c) Arrhenius d) All the previous

❖ Give reasons for:

1-The litmus dye is used to differentiate between acids and bases

……

……

……

2-The aqueous solution of acids and bases conduct the electric current.

……

……

……

3-According to Bronsted lowry theory water acts as an acid when it reacts with

ammonia gas and as a base when it reacts with hydrogen chloride.

……

……

……

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4-Ammonia is considered a base although it doesn't contain hydroxide group OH^-

……
……
……

❖ Compare between:

Definition of acid and base according to Arrhenius theory, lewis theory

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Part (2): Classification of acids and bases

1. According to its source into:

Organic acids

- Acids that have an organic origin (Plant or animal)
- All of them are weak acids

Examples

- ✓ Lactic acid
- ✓ Acetic acid
- ✓ Citric acid
- ✓ Oxalic acid
- ✓ Formic acid

Mineral acids

- Acids that have no organic origin

Or have non metallic element in their structure.

- Some are weak and some are strong

Examples

- ✓ Carbonic acid
- ✓ Hydrochloric acid
- ✓ Phosphoric acid
- ✓ Sulphuric acid

2. According to the number of hydrogen atoms that the acid react through it (basisty of acid)

Mono basic acids

When it dissolves in water each molecule gives one proton.

Examples

- ✓ Hydrochloric acid (HCl)
- ✓ Nitric acid (HNO3)
- ✓ Acetic acid (CH3COOH)
- ✓ Formic acid(HCOOH)

Dibasic acids

When it dissolves in water each molecule gives one or two protons.

Examples

1. Sulphuric aci(H_2SO_4)
2. Carbonic acid(H_2CO_3)
3. Oxalic acid

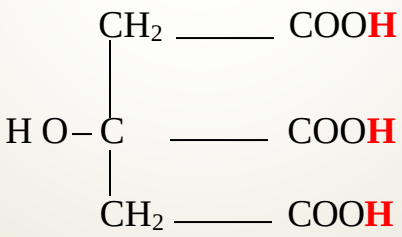
COOH
|
COOH

Tribasic acids

They are acids that can give three protons through reactions

Examples

4. Phosphoricacid (H_3Po_4)
5. Citric acid



3. According to its strength into:

Strong acids

Acids which are completely ionized in water

Examples

- ✓ Hydrochloric acid (HCl)
- ✓ Nitric acid (HNO_3)
- ✓ Sulphuric acid (H_2SO_4)

Weak acids

Acids which are incompletely ionized in water

Examples

- ✓ Acetic acid (CH_3COOH)
- ✓ Formic acid(HCOOH)
- ✓ Oxalic acid

Classification of bases

1. According to its molecular composition

Base	Examples	Application
1-Metal oxides	Iron (II)oxide FeO	$FeO + 2HCl \longrightarrow FeCl_2 + H_2O$
2-Metal hydroxide	Calcium hydroxide $Ca(OH)_2$	$Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 + 2H_2O$
3-Metal carbonate	Potassium carbonate K_2CO_3	$K_2CO_3 + 2HCl \longrightarrow 2KCl + H_2O + CO_2$

4-Metal bicarbonates	Potassium bicarbonate $KHCO_3$	$KHCO_3 + HCl \longrightarrow KCl + H_2O + CO_2$

2. According to its strength:

Strong bases

Bases which are completely ionized in water

Examples:

- ✓ Potassium hydroxide (KOH)
- ✓ -Sodium hydroxide (NaOH)

Weak bases

Bases which are incompletely ionized in water

Examples:

- ✓ -Ammonium hydroxide (NH_4OH)

Bases that dissolve in water are called alkalis.
So all alkalis are bases but not all bases are alkalis.

Detecting acids and bases

By PH meter or indicators

Indicators:

They are weak organic acids or bases their color changes with the change of the solution type.

Indicator	Colour in acidic medium	Colour in neutral medium	Colour in basic medium
Methyl orange	Red	Orange	Yellow
Bromothymol blue	Yellow	Green	Blue
Phenolphthalein	Colourless	Colourless	Pink
Litmus	Red	Violet	Blue

By PH meter

- ✓ PH < 7 so the substance is acid PH = 7
- ✓ so the substance is neutral PH > 7
- ✓ so the substance is basic

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Chapter 2

Part 2

❖ Write the scientific term:

1-Acids that are completely ionized in water and their solutions are good conductor of electricity. (… .....)

2-Acids that have organic origin. (…….)

3-Acids that usually have a non metal element in their composition. (……..……)

4-The number of protons produced from one molecule of the acid when it dissolves in water. (……..……)

5-The acid when it dissolves in water each molecule gives one or two protons. (……..……)

6-Bases that their solutions are good conductor of electricity. (……..……)

7-A weak acid or base that changes its color with the change of PH value of the solution. (….....)

❖ Choose the correct answer:

1-Each molecule of sulphuric acid ionizes in water giving……..

a)1 proton b)2 proton c)3 proton d)(a) & (b)

b) 2-Sodium hydroxide is.....base

a) weak b)strong c)neutral d)no correct answer

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3-The color of methyl orange in the acidic medium is……

a)yellow b)green c)orange d)red

4-All the following are monobasic acids except…….

a)hydrochloric b)nitric c)acetic d)oxalic

5-The PH value in which the color of phenolphthalein turns into red is……..

a) 2 b) 4 c) 6 d) 9

❖ Give reasons for:

1-Nitric acid is a good conductor of electricity

……

……

2-Acetic acid is monobasic while phosphoric acid is tribasic acid.

……

……

3-Phenolphetahien cannot be used to differentiate between acidic and neutral medium.

……

……

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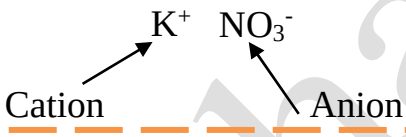
Part (3): Salts

Salt are found in earth crust, dissolved in sea water or precipitated in the seabed .

Salt formed from

- ✓ ***Cation***: A positive ion of the base.
- ✓ ***Anion:*** A negative ion of the acid.

Example: potassium nitrate



Monobasic acids form only one type of salts
As (Nitric acid HNO3)…….forms nitrates salts only

Dibasic acids form two type of salts
As (Sulphuric acid H2SO4)…….forms sulphate and bisulphate salts

Tribasic acids form three type of salts
As (Phosphoric acid H3PO4)…….forms three types of salts

Mr. Ibrahim Elbawary

Formation of salts

Reaction of diluted acid with active metals

When metal is more active than hydrogen

$$Zn_{(s)} + H_2SO_{4(aq)} \xrightarrow{dil} ZnSO_{4\,(aq)} + H_{2(g)}\uparrow$$

Reaction of metal oxides with acids

When metal is less active than hydrogen

$$CuO_{(S)} + H_2SO_{4(aq)} \xrightarrow{\Delta} CuSO_{4(aq)} + H_2O_{(l)}$$

Reaction of metal hydroxides with acids

$$NaOH_{(aq)} + HCl_{(aq)} \xrightarrow{\Delta} NaCl_{(aq)} + H_2O_{(l)}$$

Reaction of metal carbonates or bicarbonates with acid (acidity test)

$Na2CO3(aq) + 2HCl(aq) \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_2 \uparrow$

Formation of salts

Acidic salts

Produced from reaction of

Strong acid and weak base

As: NH_4Cl produced from (NH_4OH & HCl)

Basic salts

Produced from reaction of

Strong base and weak acid

As: Na2CO3 produced from (NaOH & H2CO3)

Neutral salts

Produced from reaction of

- ✓ **Strong acid and strong base**
  As: NaCl produced from (NaOH & HCl)
- ✓ **Weak acid and weak base**
  As: CH3COONH4 produced from (CH3COOH & NH4OH)

Chapter 2

Part 3

❖ Write the scientific term:

1. The compound which is formed when an anion combines with a cation
   (……..……)
2. The salt which is produced from the reaction between a strong acid and weak base. (…..)
3. The acidic radical of the salt (…..)

❖ Choose the correct answer:

1-The acidic radical of $NaHSO_4$ is…….

a) Na^+ b) HSO_4^- c)SO_4^{-2} d)H^+

2-The chemical formula of iron (III) sulphate is……

a) $FeSO_4$ b)$Fe_2(SO_4)_3$ c)$Fe_3(SO_4)_2$ d)Fe_2SO_4

3-The ..... acid has three types of salts

a) phosphoric b)carbonic c) sulphuric d)nitric

4-Salts are formed when acid reacts with…….

a) bases b)metal oxide c)metal carbonate d)all the previous

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5-The color of litmus dye doesn't change when it is added to a solution of……

a)NH_4Cl b)K_2CO_3 c)$NaNO_3$ d)KCl

6-$(CH3COO)_2Cu$ is named……

a)calcium II oxalate b)copper I acetate

c)calcium II acetate d)copper II acetate

❖ Give reasons for:

1-Sodium carbonate is a base

……

……

❖ Use the following radicals to form salts:

a) NO_3^-

……

b) SO_4^{-2}

……

c) Cl^-

……

❖ Write the name of sodium salts of:

1-sulphuric acid

……

……

2-Carbonic acid

……

……

sherif hawary